Dataset Expocode	**33RR20160321**
Primary Contact	**Name:** Sullivan, Kevin **Organization:** NOAA/AOML CIMAS **Address:** 4301 Rickenbacker Causeway, Miami, Fl 33149 **Phone:** (305) 361-4382 **Email:** kevin.sullivan@noaa.gov
Investigator	**Name:** Wanninkhof, Rik **Organization:** NOAA/Atlantic Oceanographic & Meteorological Laboratory **Address:** 4301 Rickenbacker Causeway, Miami Fl, 33149 **Phone:** 305-361-4379 **Email:** Rik.Wanninkhof@noaa.gov
Investigator	**Name:** Pierrot, Denis **Organization:** NOAA/Atlantic Oceanographic & Meteorological Laboratory **Address:** 4301 Rickenbacker Causeway, Miami Fl, 33149 **Phone:** 305-361-4441 **Email:** Denis.Pierrot@noaa.gov
Dataset	**Funding Info:** NOAA Climate Program Office **Initial Submission (yyyymmdd):** 20160721 **Revised Submission (yyyymmdd):** 20160721
Campaign/Cruise	**Expocode:** 33RR20160321 **Campaign/Cruise Name:** I09N **Campaign/Cruise Info:** AOML_SOOP_CO2; I09N L.Barbero (AOML) chief scientist **Platform Type:** **CO2 Instrument Type:** Equilibrator-IR or CRDS or GC **Survey Type:** Research Cruise **Vessel Name:** Roger Revelle **Vessel Owner:** U.S. Navy; operated by Scripps Institute of Oceanography **Vessel Code:** 33RR
Coverage	**Start Date (yyyymmdd):** 20160321 **End Date (yyyymmdd):** 20160427 **Westernmost Longitude:** 84.7 E **Easternmost Longitude:** 115.6 E **Northernmost Latitude:** 17.9 N **Southernmost Latitude:** 32 S **Port of Call:** Fremantle, Australia **Port of Call:** Phuket, Thailand
Variable	**Name:** xCO2_EQU_ppm **Unit:** ppm **Description:** Mole fraction of CO2 in the equilibrator headspace (dry) at equilibrator temperature (ppm)
Variable	**Name:** xCO2_ATM_ppm **Unit:** ppm **Description:** Mole fraction of CO2 measured in dry outside air (ppm)
Variable	**Name:** xCO2_ATM_interpolated_ppm **Unit:** ppm

	Description: Mole fraction of CO2 in outside air associated with each water analysis. These values are interpolated between the bracketing averaged good xCO2_ATM analyses (ppm)
Variable	**Name:** PRES_EQU_hPa **Unit:** hPa **Description:** Barometric pressure in the equilibrator headspace (hPa)
Variable	**Name:** PRES_ATM@SSP_hPa **Unit:** hPa **Description:** Barometric pressure measured outside, corrected to sea level (hPa)
Variable	**Name:** TEMP_EQU_C **Unit:** Degree C **Description:** Water temperature in equilibrator (°C)
Variable	**Name:** SST_C **Unit:** Degree C **Description:** Sea surface temperature (°C)
Variable	**Name:** SAL_permil **Unit:** ppt **Description:** Sea surface salinity on Practical Salinity Scale (o/oo)
Variable	**Name:** fCO2_SW@SST_uatm **Unit:** µatm **Description:** Fugacity of CO2 in sea water at SST and 100% humidity (µatm)
Variable	**Name:** fCO2_ATM_interpolated_uatm **Unit:** µatm **Description:** Fugacity of CO2 in air corresponding to the interpolated xCO2 at SST and 100% humidity (µatm)
Variable	**Name:** dfCO2_uatm **Unit:** µatm **Description:** Sea water fCO2 minus interpolated air fCO2 (µatm)
Variable	**Name:** WOCE_QC_FLAG **Unit:** None **Description:** Quality control flag for fCO2 values (2=good, 3=questionable)
Variable	**Name:** QC_SUBFLAG **Unit:** None **Description:** Quality control subflag for fCO2 values, provides explanation when QC flag=3
Sea Surface Temperature	**Location:** Hydro Lab, near CO2 system **Manufacturer:** Seabird **Model:** 45 **Accuracy:** 0.002 (°C if units not given) **Precision:** 0.0002 (°C if units not given) **Calibration:** Factory calibration **Comments:** Manufacturer's Typical Stability is taken as Precision; Maintained by ship. A regression fit between the average temperature measured in the Hydro Lab and the CTD surface temperature was done for all casts to estimate the SST. See additional comments below and supplemental ReadMe file.
Sea Surface Salinity	**Location:** In Hydro lab, near CO2 system **Manufacturer:** Seabird

Model: SBE 45
Accuracy: ± 0.005 o/oo
Precision: 0.0002 o/oo
Calibration: Factory calibration
Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship. A regression fit between the average salinity measured in the Hydro Lab and the CTD surface salinity was done for all casts to adjust the SSS. See additional comments below and supplemental ReadMe file.

Atmospheric Pressure

Location: On MET mast, ~17 m above the sea surface water
Normalized to Sea Level: yes
Manufacturer: RMYoung
Model: 61302V
Accuracy: ± 0.3 hPa (hPa if units not given)
Precision: 0.01 hPa (hPa if units not given)
Calibration: Factory calibration
Comments: Manufacturer's Resolution is taken as Precision; Maintained by ship.

Atmospheric CO2

Measured/Frequency: Yes, 5 readings in a group every 4.5 hours
Intake Location: Bow mast, ~18 meters above sea surface
Drying Method: Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).
Atmospheric CO2 Accuracy: ± 0.5 µatm in fCO2_ATM
Atmospheric CO2 Precision: ± 0.01 µatm in fCO2_ATM

Aqueous CO2 Equilibrator Design

System Manufacturer:
Intake Depth: 5 meters
Intake Location: Bow, or engine room sea chest (mid ship)
Equilibration Type: Spray head above dynamic pool with thermal jacket
Equilibrator Volume (L): 0.95 L (0.4 L water, 0.55 L headspace)
Headspace Gas Flow Rate (ml/min): 70 - 150 ml/min
Equilibrator Water Flow Rate (L/min): 1.3 - 2.5 L/min
Equilibrator Vented: Yes
Equilibration Comments: Primary equilibrator is vented through a secondary equilibrator.
Drying Method: Gas stream passes through a thermoelectric condenser (~5 °C) and then through a Perma Pure (Nafion) dryer before reaching the analyzer (90% dry).

Aqueous CO2 Sensor Details

Measurement Method: IR
Method details: details of CO2 sensing (not required)
Manufacturer: LI-COR
Model: 6262
Measured CO2 Values: xco2(dry)
Measurement Frequency: Every 140 seconds, except during calibration
Aqueous CO2 Accuracy: ± 2 µatm in fCO2_SW
Aqueous CO2 Precision: ± 0.01 µatm in fCO2_SW
Sensor Calibrations:
Calibration of Calibration Gases: The analyzer is calibrated every 4.5 hours with field standards that in turn were calibrated with primary standards that are directly traceable to the WMO scale. The zero gas is ultra-high purity air.
Number Non-Zero Gas Standards: 4
Calibration Gases:

Std 1: JA02280, 233.46 ppm, owned by AOML, used every ~4.5 hours.
Std 2: JA02264, 326.18 ppm, owned by AOML, used every ~4.5 hours.
Std 3: JA02285, 406.06 ppm, owned by AOML, used every ~4.5 hours.
Std 4: JA02646, 463.00 ppm, owned by AOML, used every ~4.5 hours.
Std 5: 0.00 ppm, owned by AOML, used every ~23.5 hours.

Comparison to Other CO2 Analyses:

Comments:

Method Reference:

Pierrot, D., C. Neil, K. Sullivan, R. Castle, R. Wanninkhof, H. Lueger, T. Johannessen, A. Olsen, R. A. Feely, and C. E. Cosca (2009), Recommendations for autonomous underway pCO2 measuring systems and data reduction routines, Deep-Sea Res II, 56, 512-522.

Equilibrator Temperature Sensor

Location: Inserted into equilibrator ~5 cm below water level
Manufacturer: Hart
Model: 1523
Accuracy: 0.015 (°C if units not given)
Precision: 0.001 (°C if units not given)
Calibration: Factory calibration
Comments: Resolution is taken as Precision.

Equilibrator Pressure Sensor

Location: Attached to equilibrator headspace. The differential pressure reading from Setra 239, which is attached to the equilibrator headspace, is added to the pressure reading from the LICOR analyzer, which is measured by an external Setra 270 connected to the exit of the analyzer.
Manufacturer: Setra
Model: 270
Accuracy: 0.15 (hPa if units not given)
Precision: 0.015 (hPa if units not given)
Calibration: Factory calibration
Comments: Manufacturer's Resolution is taken as Precision.

Additional Information

Suggested QC flag from Data Provider: NA

Additional Comments: The analytical system performed well throughout this cruise. Values for the ship's sensors were appended to the CO2 data record in real-time. Missing real-time values were taken from the MET files logged by the ship. The temperature and salinity data from the CTD casts were used to estimate SSTemperature and to adjust the SSSalinity used in the fCO2 processing. A regression fit between the average temperature measured in the Hydro Lab (HLT) and the CTD surface temperature was done for all casts. After eliminating eleven outlying data, the resulting second degree polynomial equation was used to estimate the SST. SST(estimated) = 0.001424*HLT^2 + 0.950053*HLT + 0.048227 ; standard deviation of the differences between the CTD temperatures and the SST(estimated) is +/- 0.061 degree Celcius. A regression fit between the average salinity measured in the Hydro Lab (HLS) and the CTD surface salinity was done for all casts. After eliminating six outlying data, the resulting linear equation was used to adjust the SSS. SSS(adjusted) = 1.003444*HLS - 0.099042 ; standard deviation of the differences between the CTD salinities and the SSS(adjusted) is +/- 0.0243 psu. See supplemental ReadMe file.

Citation for this Dataset:

Other References for this Dataset: